NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)
Code 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes.

- To stabilize the grade and control erosion in natural or artificial channels.
- To prevent the formation or advance of gullies.
- To enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion.

CRITERIA APPLICABLE TO ALL PURPOSES

General Criteria. All planned work shall comply with all Federal, State, and local laws and regulations. Grade stabilization structures may need to be approved or permitted by the appropriate water management district (WMD) or the Florida Department of Environmental Protection (FDEP). Refer to Chapter 373 Florida Statutes (F.S.) and WMD Chapter 40-4 Florida Administrative Code (F.A.C.) for permitting requirements.

Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

Earth Embankments. Class (a) dams that have a product of storage (acre-ft) times the effective height (ft) of the dam of 3,000 or more, those more than 35 ft in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft or less shall meet or exceed the earth embankment requirements as specified in NRCS Florida conservation practice standard Pond, Code 378.

The effective height of the dam is the difference in elevation in feet between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway the top of the dam is the upper limit.

Earth embankment and emergency spillways of structures for which criteria are not provided in Florida conservation practice standard Pond, Code 378 or in TR-60, must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the required total capacity without overtopping the embankment. The foundation preparation, compaction, top width, and side slopes must ensure a stable embankment for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

The minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1 less any reduction because of detention storage. If criteria values exceed those shown in Table 1, or the storage capacity is more than 50 acre-ft, the peak flow from a 10-year frequency, 24-hour duration storm less any reduction from detention storage must be used as the minimum principal spillway capacity.

The peak flow from a 25-year frequency, 24-hour duration storm, less any reduction creditable to principal spillway discharge and detention storage, must be used as the minimum emergency spillway design storm.

Grade stabilization structures with a settled fill height of less than 15 feet and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, may be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in the design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm.

The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical (5:1), and neither slope shall be steeper than 2 horizontal to 1 vertical (2:1). All slopes must be designed to be stable. Where embankments are to be mowed; 3 horizontal to 1 vertical (3:1) or flatter slopes are recommended.

Compaction of the embankment fill material shall be in accordance with the specified design requirements for compaction and moisture content. Maximum thickness of earthfill layers will be 9 inches. If for any reason the designer is of the opinion that more stringent compaction requirements are necessary, percent of standard proctor and moisture limits may be specified. The design height of the embankment shall be increased by the amount needed to ensure that after settlement has taken place, the constructed height of embankment will equal or exceed the design height. This settlement shall not be less than 3 percent for rubber tired pans and scrapers and 5 percent for track type equipment such as bulldozers, except where detailed soil testing and laboratory analysis shows a lesser amount is adequate or field observations indicate a greater amount is needed to obtain the needed level of compaction.

Table 1. Design criteria for establishing minimum capacity of the principal spillway and emergency spillway for dams with storage capacity of less than 50 ac-ft.

Drainage Area	**Effective Height of Dam**	**Principal Spillway - Minimum 24-Hour Duration Frequency Design Storm[1/]**	**Emergency Spillway - Minimum 24-Hour Duration Frequency Design Storm[1/]**
acres	feet	year	year
≤ 100	35 or less	2	25
> 100 ≤ 200	35 or less	5	25

[1/] Grade stabilization structures with a settled fill height of less than 15 feet and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in the design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm.

Full Flow Open Structures. Straight drop spillways, drop boxes, chute spillways, and box inlet drop spillways shall be designed according to the principles set forth in the NRCS National Engineering Field Handbook Part 650, the National Engineering Handbook Series and other applicable NRCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. If site conditions exceed those shown in Table 2, the minimum design 24-hour storm frequency is 25 years for the principal spillway less any reduction from detention storage and 100 years less any reduction creditable to principal spillway discharge and detention storage for the total capacity.

Structures must not create unstable conditions upstream or downstream. Provisions must be made to ensure safe reentry of bypassed flows.

Toe wall drop structures can be used if the vertical drop is 4 ft or less, flows are intermittent, downstream grades are stable, and tailwater depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or the capacity specified in Table 2 less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Structures with flashboard risers shall be designed to handle the design discharge with the water surface below the crest of emergency spillway with all the flashboards in place.

If the mechanical spillway is designed as an island-type structure, its minimum capacity shall be equal to or greater than the capacity of the downstream channel. For channels with drainage areas of 40 acres or less, the mechanical spillway shall have the minimum capacity of removing the runoff from a 2-year, 24 hour storm in 24 hours or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration for total capacity shown in Table 2, less any reduction creditable to principal spillway discharge and detention storage without overtopping the headwall extensions of the mechanical spillway. Provisions must be made for safe reentry of bypassed flow as necessary.

Table 2. Design criteria for establishing minimum capacity of full-flow open structures.

		Frequency of Minimum Design, 24-Hour Duration Storm	
Maximum Drainage Area	**Vertical Drop**	**Principal Spillway Capacity**	**Total Capacity**
acres	feet	year	year
250	$\leq$ 5	5	10
500	$\leq$ 10	10	25

Side-inlet Drainage Structures. The design criteria for minimum capacity of open-weir or pipe drop drainage structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown

in Table 3. For all conditions shown in Table 3, the minimum principal spillway capacity shall be equal to or greater than the design drainage curve runoff. If site condition values exceed those shown in Table 3, the 50 year frequency storm shall be used for minimum design of total capacity less any reduction creditable to principal spillway discharge and detention storage. Provisions must be made to prevent damage from overtopping the structure and to divert excess flows away from the structure. On structures with drainage areas of 3 acres or less, overtopping of the structure is permitted only if damage will be minor and island type construction will interfere with normal farming operations.

Side-inlet structures with flashboard risers shall be designed to handle the design discharge with the water surface below the crest of the emergency spillway with all the flashboards in place.

Earth embankment side slopes may be as steep as 1.5 horizontal to 1 vertical (1.5:1) on pipe island-type or side-inlet drainage structures where the effective height is less than 10 feet and the vertical drop is less than 10 feet from natural ground to channel bottom or normal downstream water level.

Seepage Control. Seepage control is to be included if (1) seepage will create unstable conditions downstream, (2) it is needed to ensure a stable embankment or (3) special circumstances require drainage for a stable structure. Seepage

may be controlled by foundation, abutment or embankment drains.

Seepage along pipes extending through the embankment may be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose. Anti-seep collars and drainage diaphragms shall meet the requirements of NRCS Florida conservation practice standard for Pond, Code 378.

Table 3. Design criteria for establishing minimum capacity of side-inlet (open-weir or pipe drop) drainage structures.

		Frequency of Minimum Design, 24-Hour Duration Storm	
Maximum Drainage Area	**Vertical Drop**	**Receiving Channel Depth**	**Total Capacity**
acres	feet	feet	year
250	0 - 5	0 - 10	1/
250	>5 -10	>10 - 20	10
500	0 -10	0 - 20	25

1/ Total capacity shall be equal to or greater than the design drainage curve runoff.

Trash Guards. Where needed to prevent clogging of the conduit, an approved type of trash rack shall be installed on the riser of drop inlets. Openings for trash racks shall be no larger than one-half of the barrel conduit diameter, but in no case less than 6 inches. The total cross sectional area of the trash rack openings shall be equal to or greater than the area of the box or riser being protected.

Antivortex Device. Drop inlet pipe spillways shall be installed with an antivortex device where needed to prevent the formation of vortices. Antivortex devices shall be designed in accordance with ARS-NC-33, Hydraulics of Closed Conduit Spillways, Part XIV.

Materials. Structures installed under this standard shall be constructed of durable material with a life expectancy equal to the planned life of the structure. Pipe conduits used in grade stabilization structures shall meet the requirements as stated in NRCS Florida conservation practice standard for Pond, Code 378.

Polyethylene, Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S may be used for grade stabilization structures with a hydraulic head of 10 feet or less. Pipe connections must be water tight.

Concrete appurtenances used shall be designed for the anticipated loading and shall meet the requirements of NRCS Construction Specification 32, Concrete for Minor Structures.

Sediment Storage. Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Safety. Earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. Areas shall be vegetative in accordance with NRCS Florida conservation practice standard Critical Area Planting, Code 342.

CONSIDERATIONS

Structures located in areas used for livestock or in urban areas should be fenced as necessary to control access and exclude traffic to prevent damage to the structure from vandalism, as well as preventing serious injury to trespassers.

Where conditions preclude or make it difficult to establish vegetative cover, consider using non-vegetative coverings such as gravel, geoweb, gabions, interlocking blocks or other type of protection.

Grade stabilization structures with detention storage may affect the volume and rates of runoff, evaporation, deep percolation and ground water recharge.

Grade stabilization structures may trap sediment and sediment attached substances carried by runoff. Consideration should be given to the amount of sediment that will be deposited and allowances made for removal.

In highly visible public areas and those associated with recreation, careful considerations should be

given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

The susceptibility of downstream stream banks and stream beds to erosion should be considered in selecting the type of outlet and in determining the final grade of the outlet channel.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Operation and maintenance shall be in accordance with the requirements of this standard and in keeping in conformance with all local, state, and federal laws and regulations.

The grade stabilization structure should be inspected periodically to ensure that the structure functions as planned.

Inspect vegetation on all earthfills. Mow when vegetative growth becomes excessive. Repair and/or fertilize damaged vegetation in accordance with NRCS FL conservation practice standard Critical Area Planting, Code 342.

Inspect structures for deterioration and capacity. Remove any blockage of trash and debris that could affect flows through the structure. Repair or replace materials that have deteriorated, including rock used for outlet protection.

Inspect for safety of people or animals using the area near the structure.

Periodically remove sediment if storage is less than the expected accumulation during the design life.

REFERENCES

AASHTO M252, M294
ARS-NC-33
ASTM D1248, D3350
Chapter 40-4 F.A.C
Chapter 373 F.S.
National Engineering Handbook, Part 650, Engineering Field Handbook
NRCS Construction Specification 32, Concrete for Minor Structures
NRCS Florida Conservation Practice Standards:
Critical Area Planting, Code 342
Pond, Code 378
Technical Release No. 60

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

GRADE STABILIZATION STRUCTURE

(No.)
Code 410

SCOPE

This item shall include all work necessary for the installation of the grade stabilization structure. Construction operations shall be carried out in such a manner that erosion, air, water and noise pollution will be minimized and held within legal limits as established by state or local regulations.

Specified materials shall provide stability, durability, and safety characteristics required to achieve the planned objective.

SITE PREPARATION

All brush, trees, stumps, fence rows, and other objectionable material hall be removed an disposed of in such a way that it will not interfere with constructing, shaping, or proper functioning of the grade stabilization structure.

Topsoil shall be stockpiled and spread where needed to provide a seedbed for areas to be vegetated.

EARTHFILL

Material. The fill material shall be taken from approved designated borrow areas. It shall be free of roots, stumps, wood, rubbish, stones greater than 6", frozen or other objectionable materials.

Placement. Areas on which fill is to be placed shall be scarified prior to placement of fill. The placing and spreading of the fill material shall be started at the lowest point of the foundation and shall be brought up in approximately horizontal layers not exceeding 8 inches in thickness (before compaction). The layers shall be of approximately the same elevation and shall extend over the entire area of the fill. The most permeable borrow material shall be placed in the downstream portions of the embankment.

Compaction. The construction equipment shall be operated over the area of each layer in a manner that will result in the specified compaction of the fill material. A minimum of two complete passes of the construction equipment over each layer must be obtained after the layer has been spread to the layer thickness. Special compaction equipment shall be used when the required compaction cannot be obtained by the routing of equipment.

The moisture content of the fill material shall be such that the specified compaction can be obtained with the equipment used. The fill material shall contain sufficient moisture so that if formed into a ball it will not crumble yet not be so wet that water can be squeezed out. The moisture content of the fill shall be maintained within the limits to (1) prevent the bulking or dilatence of the material under the action of the hauling or compaction equipment, (2) prevent adherence of the fill material to the equipment and (3) ensure the crushing and blending of the soil clods and aggregation into a homogeneous mass.

Cutoff Trench. Where required, the cutoff trench shall be excavated into impervious material along or parallel to the centerline of the embankment as shown on the plans. The bottom width of the trench shall be governed by the equipment used for excavation, with the minimum width being four feet. The depth shall be as shown on the plans. The side slopes of the trench shall be 1 horizontal to 1 vertical (1:1) or flatter. The backfill shall be compacted with construction equipment, rollers, or hand tampers to assure maximum density and minimum permeability.

Structure Backfill. Backfill adjacent to pipes or structures shall be of the type and quality conforming to that specified for the adjoining fill material. The fill shall be placed in horizontal layers not to exceed four inches in thickness and compacted by hand tampers or other manually directed compaction equipment. The material

shall completely fill all spaces under and adjacent to the pipe. At no time during the backfilling operation shall driven equipment be allowed to operate closer than four feet, measured horizontally, to any part of a structure. Under no circumstances shall equipment be driven over any part of a concrete structure or pipe, unless there is a compacted fill of 24" or greater over the structure or pipe. The pipe shall be firmly and uniformly bedded throughout its entire length. Where rock or soft, spongy or other unstable soil is encountered, all such material shall be removed and replaced with suitable fill material compacted to provide adequate support.

All earth removed and not needed in construction shall be spread or disposed of in such a way that it will not interfere with the functioning of the grade stabilization structure. All portions of the grade stabilization structure shall be finished and smoothed in such a manner that the applied vegetative cover can be properly maintained.

MATERIALS

Pipe. All pipes shall be circular in cross section and shall meet the requirements as shown on the engineering plans.

Coupling bands, anti-seep collars, end sections, etc., must be composed of the same material as the pipe. Metals must be insulated from dissimilar materials with the use of rubber or plastic insulating materials of at least 24 mils in thickness.

All connections with pipes must be completely watertight. The pipe barrel connection to the riser shall be welded all around when the pipe and riser are metal. Anti-seep collars shall be connected to the pipe in such a manner as to be completely watertight. Dimple bands are not considered to be watertight.

Helical corrugated pipe shall have either continuously welded seams or have lock seams with internal caulking or a neoprene bead.

Other details (anti-seep collars, valves, etc.) shall be as shown on the drawings.

Concrete. Concrete shall meet the requirements of NRCS Construction Specification 32, Concrete for Minor Structures.

Rock Riprap. Rock riprap shall meet the requirements of NRCS Construction Specification 61, Rock Riprap.

Geotextile. Geotextile shall be placed under all riprap and shall meet the requirements of NRCS Construction Specification 95, Geotextile .

Any special protection materials shall be installed per manufacturers instructions.

POLLUTION CONTROL

Construction operations shall be carried out so that erosion and sediment control are addressed, and air and water pollution are minimized. This may include such items as silt fence, hay bale barrier, temporary vegetation, mulching, etc.

VEGETATION

Vegetation will be established as specified in the vegetative plan.